

NEBRASKA DEPARTMENT OF ROADS

***INSPECTION GUIDE
FOR THE INSTALLATION
OF
HIGH MAST LIGHTING AND SIGN STRUCTURES***

***Materials and Research Division
March 2008***

INSTALLATION OF HIGH MAST TOWERS & SIGN STRUCTURES

Field Installation of Sign Structures:

The Engineer or his designated representative shall be present at all times during tower and structure installation. The Contractor shall notify the Physical Tests Section of the Materials and Research Division (402-479-4746) and/or the Traffic Engineering Division (402-479-4594) to arrange for inspection no less than 3 days prior to pole installation. Members of the Physical Tests Section will visit the project site to observe the Contractor's methodology of anchor bolt installation and anchor bolt tensioning and will randomly test nuts for proper tightness. No poles or structures installed without proper inspection will be accepted by the state for final payment.

Anchor Bolts, Nuts & Washers

a. The structure manufacturer shall design and furnish the anchor bolts in accordance with AASHTO M314 Grade 55 and designed for fatigue. The contractor shall furnish an extra bolt sample (including nuts and washers) from each heat of steel used on the project (or multiple projects) to the Materials and Research Division for destructive testing. Threads on anchor bolts shall be rolled in accordance with standard industry practice; the use of cut threads shall not be permitted. The top 12 inches (300 mm) of the anchor bolt shall be cleaned and painted with zinc rich paint prior to shipment with a minimum dry film thickness of 4 mils (100 μm). The type of paint and the method of application shall be as approved by the Materials and Research Division. After installation the Contractor shall touch-up paint threads using approved methods.

Anchor bolts of the specified size shall be supplied in a welded assembly by the manufacturer (no welding on the anchor bolts will be permitted) to ensure proper bolt spacing and alignment. This assembly shall be detailed on the shop plans. The anchor assembly cage shall be placed at the depth shown in the shop plans, properly aligned and secured in place before placing concrete. Once the concrete has set, **no** adjustments or realignments shall be made to the anchor bolts. Field straightening of anchor bolts will not be permitted. The bolts shall be truly vertical, with no more than a 1/8" deviation in 12" (3 mm in 300 mm) of length permitted.

All high mast tower and cantilever sign structures shall use a **minimum** of six (6), 2-inch (50 mm) diameter anchor bolts.

All other overhead sign structures shall use a **minimum** of four (4); 2-inch (50 mm) diameter anchor bolts (4 for each support).

The Contractor's actual design may require a greater number of anchor bolts, anchor bolts of larger diameter or both. In all cases, however, anchor bolts must meet AASHTO M-314, Grade 55 Requirements.

b. The heavy hex nuts shall meet the requirements of ASTM A 563, Grade C3 or DH3.

c. The plain hardened steel washers shall conform to the requirements of ASTM F 436 Type 3 or ASTM F 436M Type 3. Only flat washers shall be used, the use of lock washers shall not be permitted.

The towers and structure supports shall be erected on the leveling nuts to a truly vertical position and then the top nuts securely tightened to the plate. The grout shall not be placed until the truss has been erected, adjusted, and bolted to final position. The final projection of the base plate above the concrete foundation shall be no greater than the thickness of two leveling nuts.

Proper Tensioning of Sign Structure Anchor Bolts and Connecting Bolts

In order to provide the correct tension to anchor bolts, the Contractor will be required to have on hand the following items:

- (1) A standard combination wrench (box end/open end) 24 inches in length for snug tightening of bolts less than 1 3/4" diameter and a Standard Combination wrench 36 inches in length for bolts equal to or greater than 1 3/4" diameter.
- (2) A deep well impact socket for final tightening, for each size nut being installed.
- (3) A torque multiplier (plate reaction style) with the following minimum requirements:

Gear Ratio:	60:1
Torque Ratio:	52:1
Output Capacity:	8000 ft.-lb.

Anchor bolt hold-down nuts and connecting bolt nuts shall be tightened by the turn-of-the-nut method as described below, but only after determining that the leveling nut/flat hardened washers for the anchor bolts are in full contact with the underside of a level base plate.

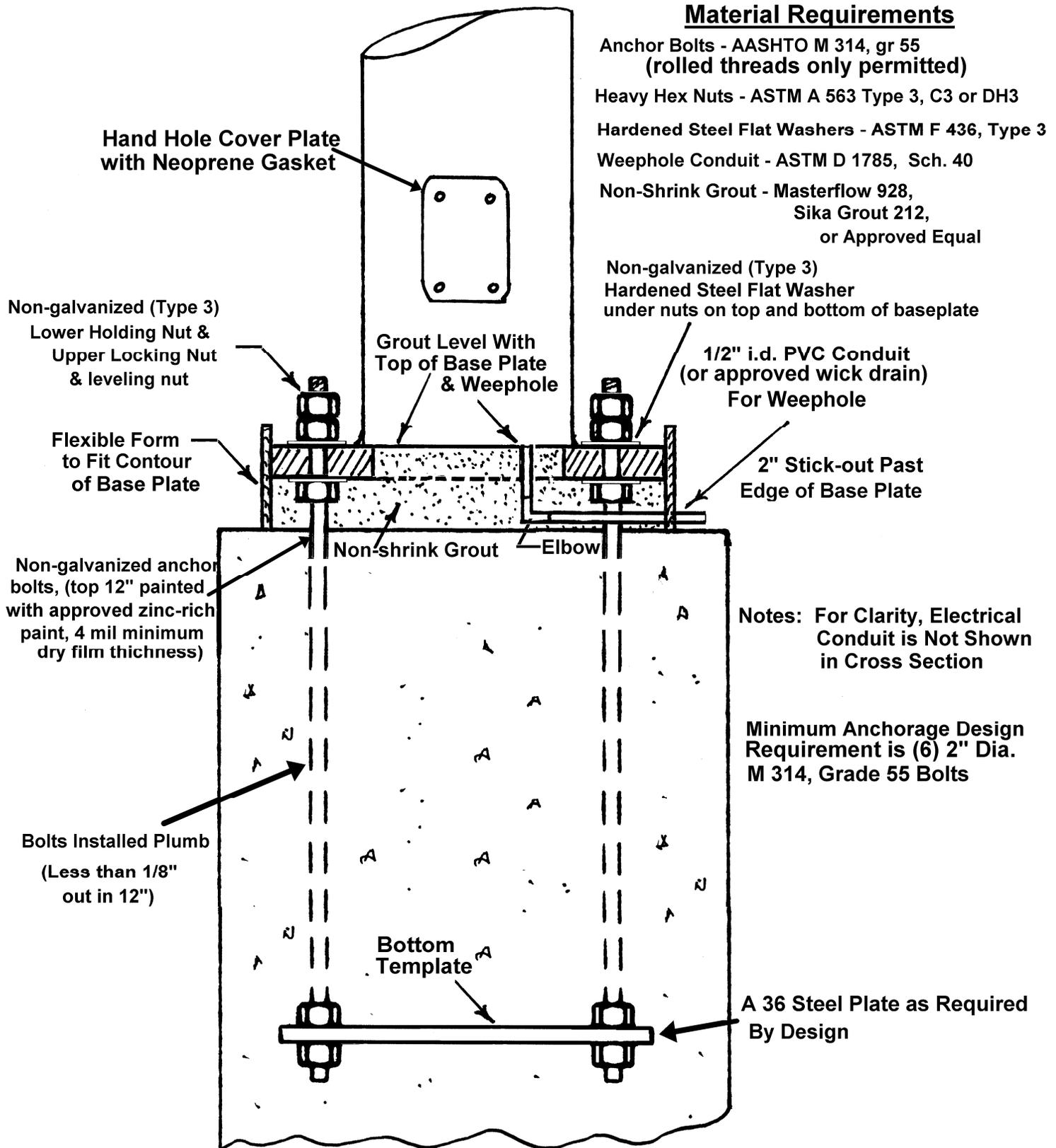
Turn-of-the-Nut Method

- (a) Lubricate the bolt threads and nut threads with a high-pressure lubricant (i.e.: SAE 90 Gear Oil or approved equal). Snug tighten (both hold down and leveling nuts) and final tighten all nuts in a "star" pattern.
- (b) Using the appropriate combination wrench, apply full effort of a workman to the end of the wrench to "snug tighten" the nut.
After the anchor bolt hold-down nuts are snug tightened, all leveling nuts should be retightened (to the snug tight position) to assure that full contact has been maintained with the bottom of the base plate.
- (c) Mark the location of one corner of the nut on the base plate.
- (d) Using the torque multiplier and the mark placed on the base plate; for nuts that are equal to or greater than 1 3/4", tighten the nut onto the anchor bolt by giving the nut 1/6th of a turn (this is equal to turning the nut onto the anchor bolt a distance equal to the length of one flat or until the next corner of the nut is even with the mark on the base plate). For nuts less than 1 3/4" diameter, use a 1/3rd of a turn.
- (e) Install a "lock nut" or "jam nut" on each of the anchor bolts by repeating steps (a) through (d).
- (f) After the top nuts are fully tightened, all leveling nuts should be retightened to assure that full contact has been maintained with the bottom of the base plate.

Connecting bolt nuts shall be tightened by the same turn-of-the-nut method as described for anchor bolts with the exception that the bolt head must be held stationary while applying the torque multiplier.

Anchor bolt and connecting bolt nuts shall be rechecked for tightness by the Contractor, in the presence of the engineer, no less than 14 days nor more than 30 days following their installation. After the tightness of the nuts has been verified, a lock nut or jam nut shall be installed on each anchor bolt to keep the hold-down nut from working loose. Locknuts or jam nuts shall be installed by repeating steps (a) thru (d) under "Turn-of-the-Nut Method" above.

After the anchor bolt and connecting bolt nuts have been rechecked for tightness, the area between the top of the foundation and the bottom of the anchor base plate shall be filled (as shown on the approved shop plan using forms and conduit / wick drains) with a high strength, non-shrink grout from the Approved Products List.



CANTILEVER SIGN & LIGHT TOWER DETAIL

Maintain bolt alignment using upper removable angles as shown,



Bolts out of plumb by more than 1/8" in 12" is not acceptable by specification.



Anchor Bolt Test Sample Submitted To NDOR For Testing



or by using removable plywood template as shown.





Require contractor to accurately level between all leveling nuts before pole is set.



Contractor must use padded slings during erection to avoid coating damage.

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Improperly set poles.

By specification, the lower edge of the baseplate must not extend above the top of the footing by more than the thickness of (2) leveling nuts.

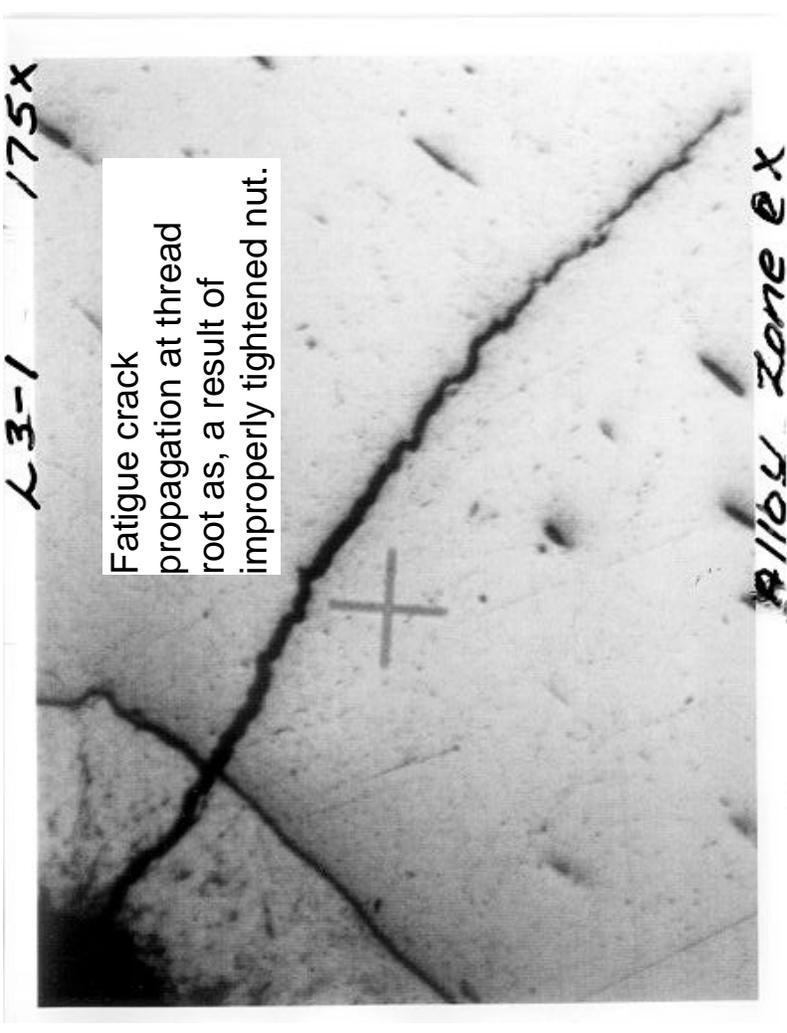




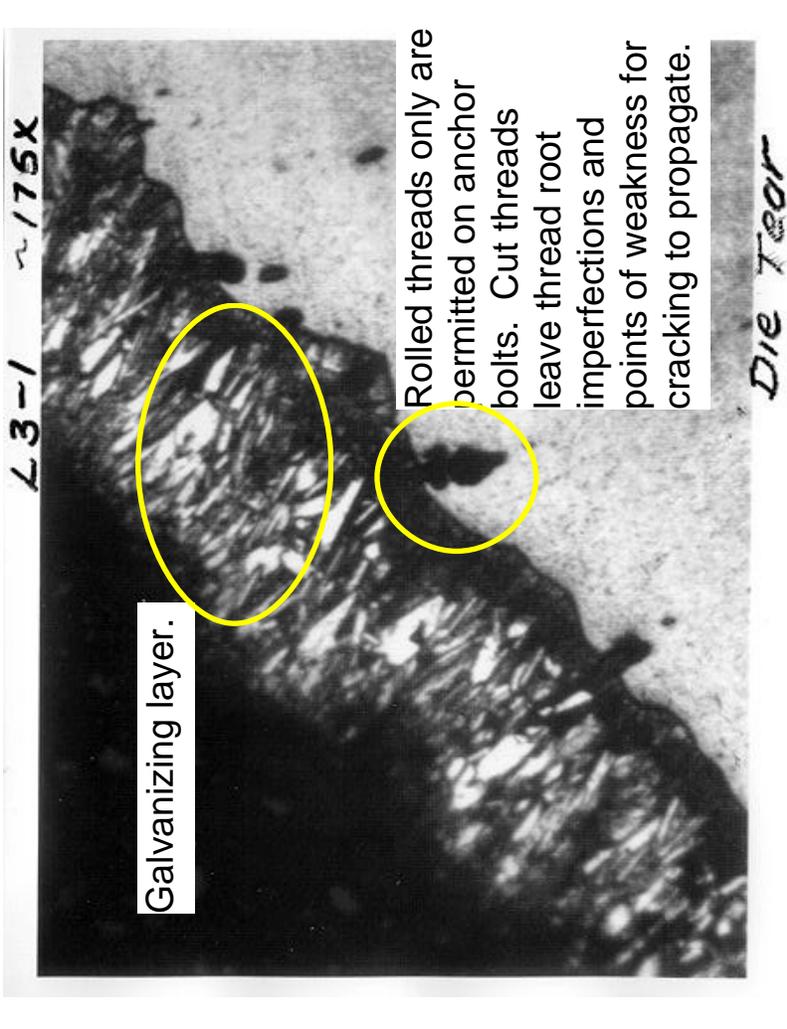
Proper setting height.



Improperly tightened lower leveling nut.



Fatigue crack propagation at thread root as a result of improperly tightened nut.



Galvanizing layer.

Rolled threads only are permitted on anchor bolts. Cut threads leave thread root imperfections and points of weakness for cracking to propagate.

Die Tear

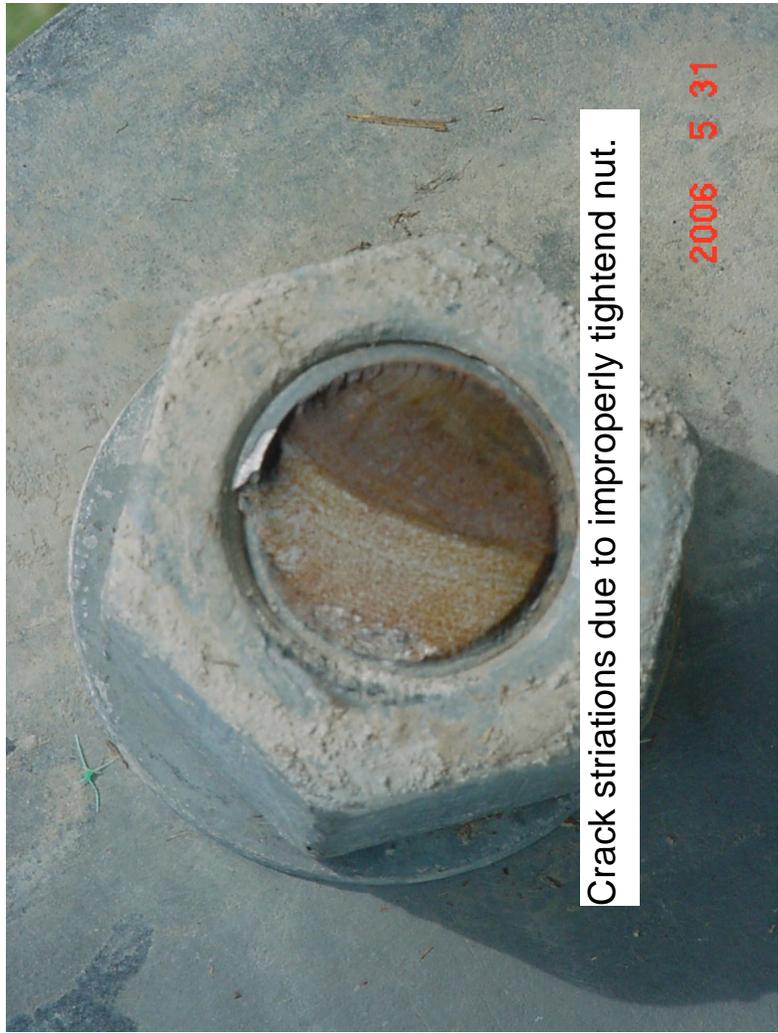


Foundations must not be buried to avoid corrosion and permit inspection.



Grout that is in need of repair.

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Crack striations due to improperly tightend nut.

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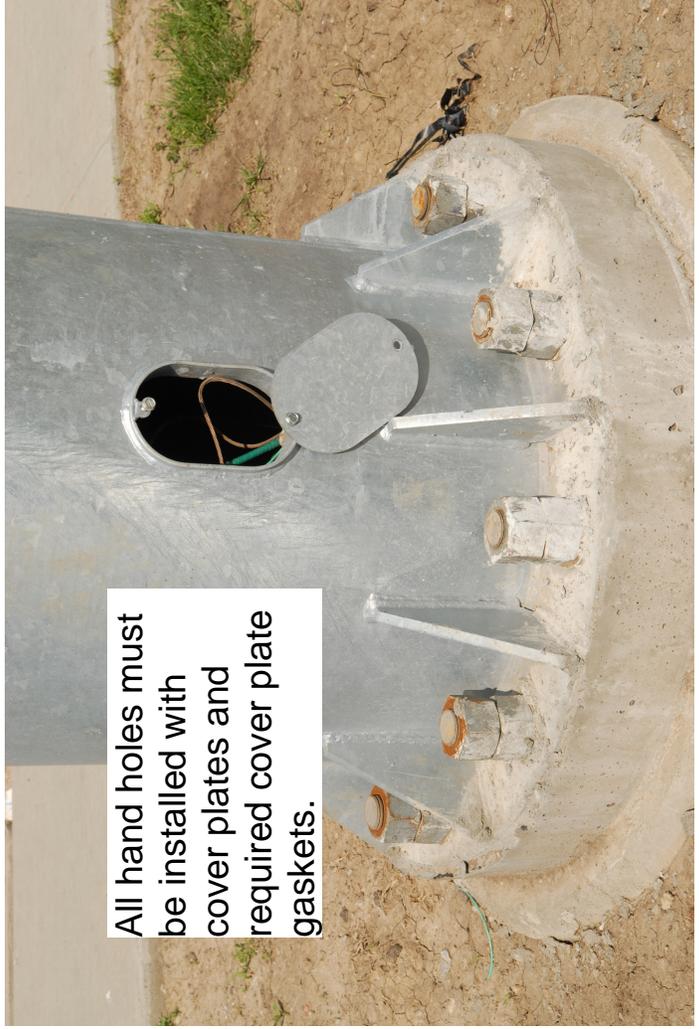


Galvanizing layer deterioration due to buried condition.



Good grouting technique, using flexible form. Grout poured through handhole.

Installed with required weep hole as shown.



All hand holes must be installed with cover plates and required cover plate gaskets.



Improper grouting technique. Anchor bolts must be completely encapsulated.

Notice improper use of wooden form.



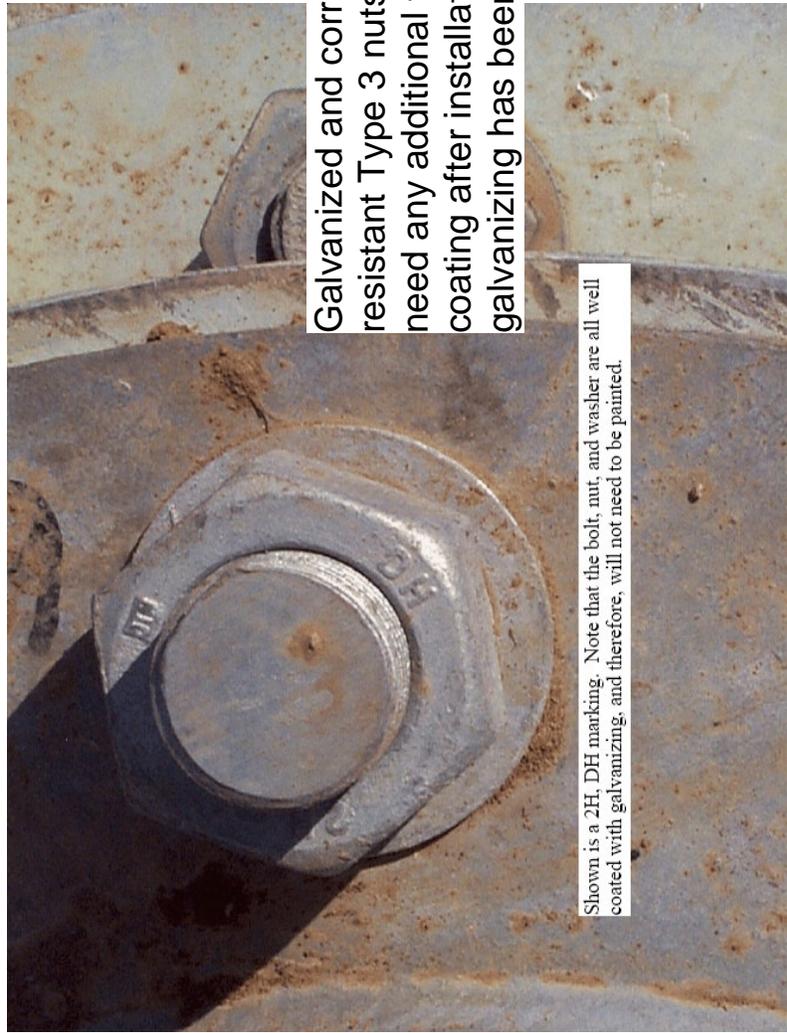
Notice functioning weep hole.

Corrosion is evident that will need attention.

Corrosion on bolts after less than one year in service.

Contractor is responsible for touching-up any damage after installation, using approved zinc rich paint (minimum 4 mil dry film thickness, to be checked by the inspector).

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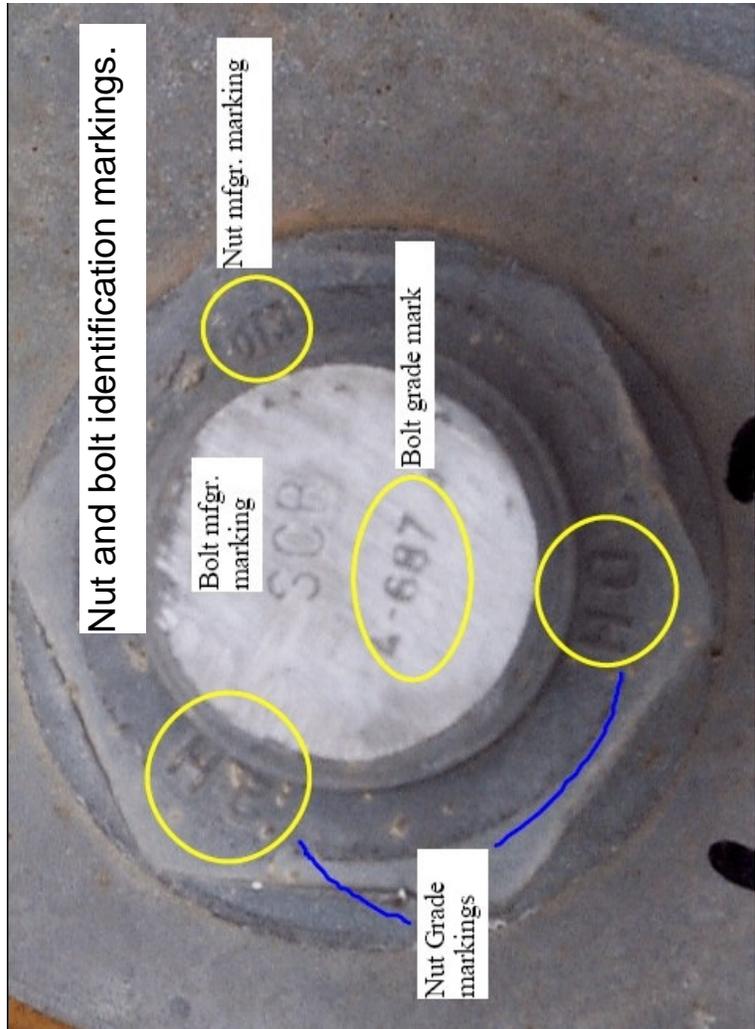
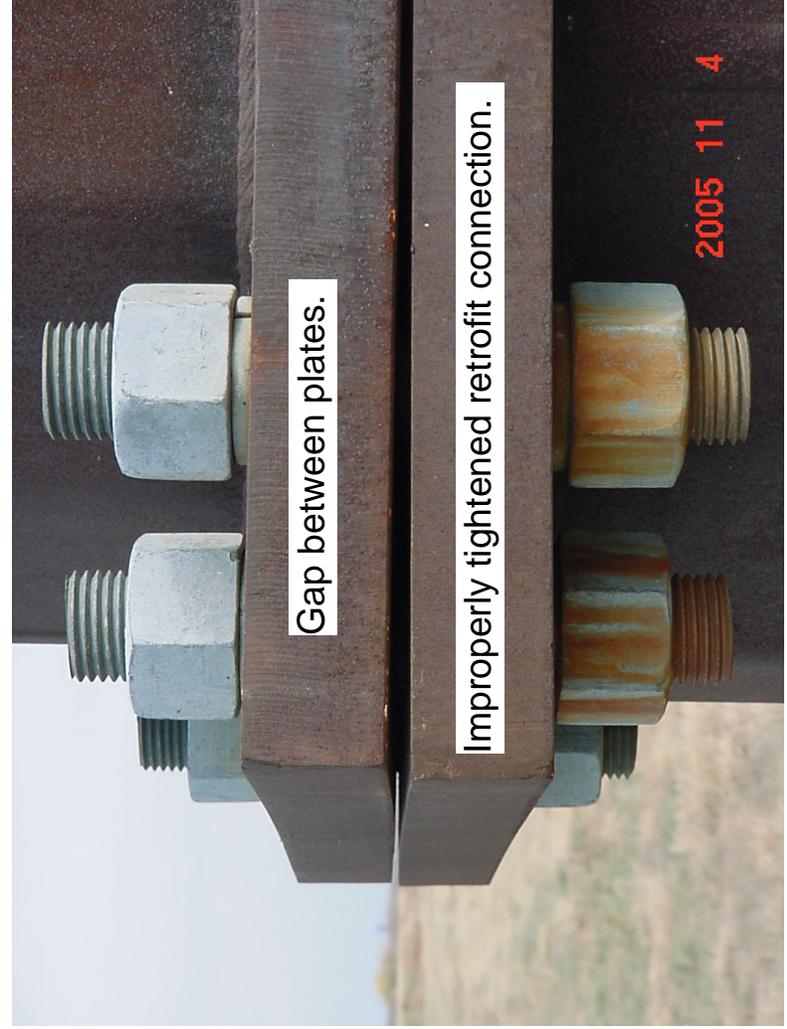
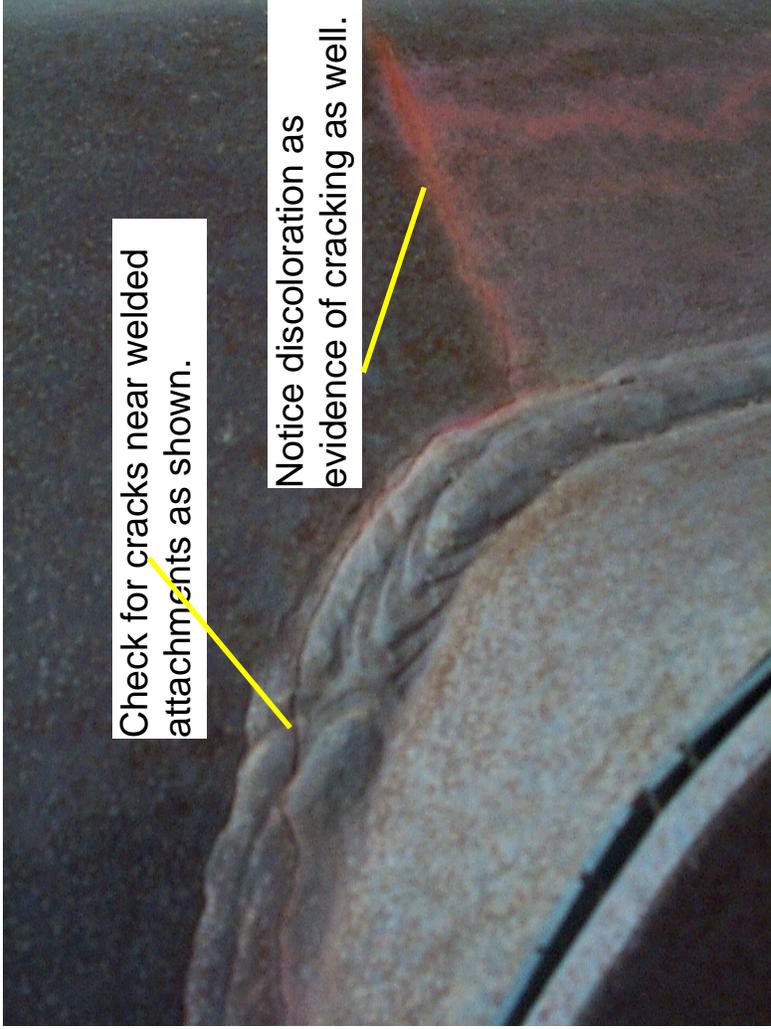


Galvanized and corrosion resistant Type 3 nuts that do not need any additional touch-up or coating after installation (unless galvanizing has been damaged).

Shown is a 2H, DH marking. Note that the bolt, nut, and washer are all well coated with galvanizing, and therefore, will not need to be painted.



Shown is a DH3 nut, and may look rusty, however, this nut is made from a special alloy that is corrosion resistant, forming a brown patina that will inhibit further corrosion. Nuts that have a C3 or DH3 marking do not need painting since they are a type 3 corrosion resistant alloy.





Proper retrofit connection with plates in contact.



Proper torque equipment.



Improper home-made wrench for tightening nuts.

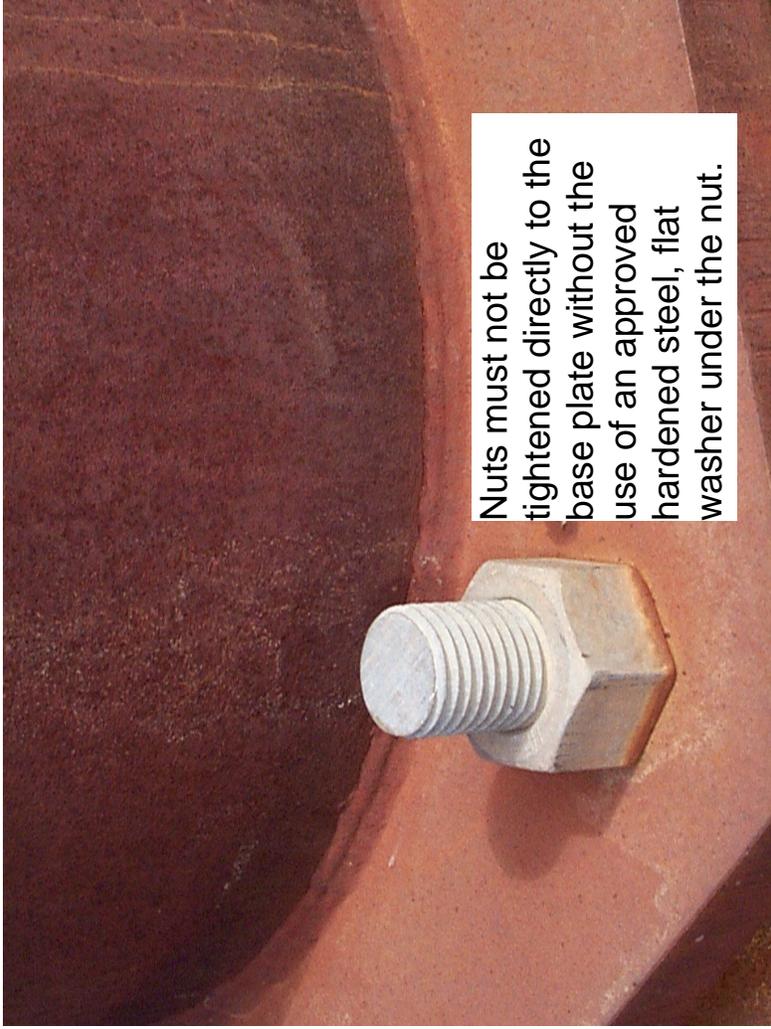


Use of (uncompressed) lock washers.



No lock washer should be used.

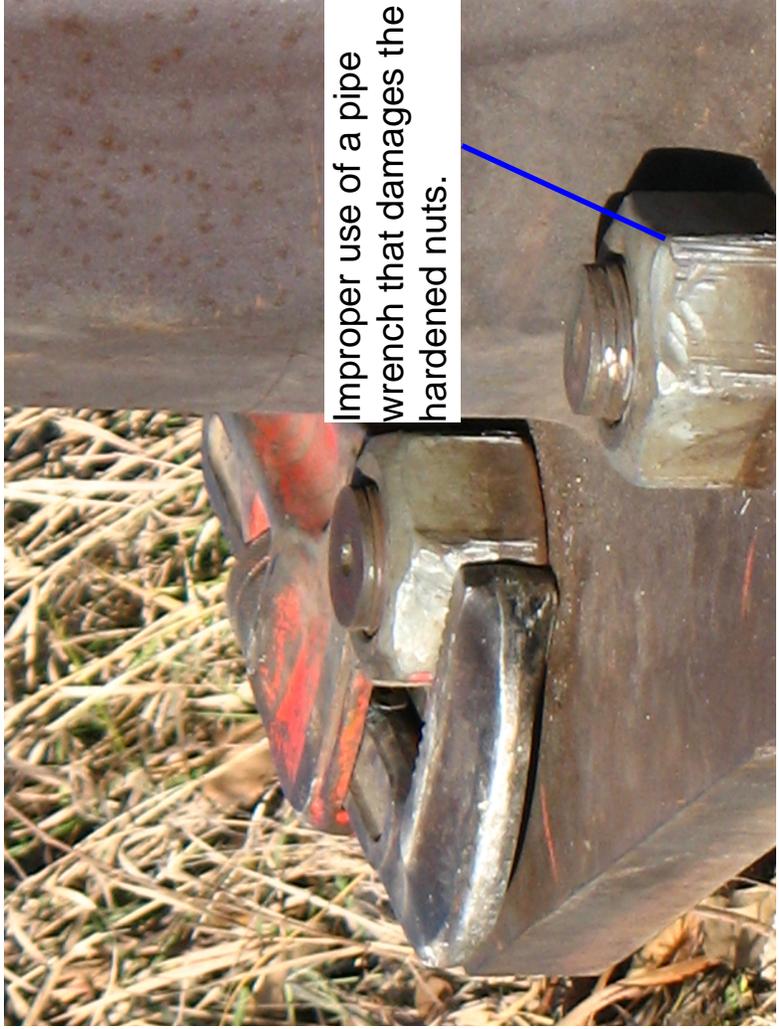
Loose nut as shown.



Nuts must not be tightened directly to the base plate without the use of an approved hardened steel, flat washer under the nut.



Proper assembly, using flat washers, and torqued top locking nuts.



Improper use of a pipe wrench that damages the hardened nuts.

Snug Tightening Wrenches

Use of proper wrenches and sockets designed for the size of the nuts being tightened.

Frequently check the tightness of the lower leveling nuts, during and after torque tightening of the top hold-down nuts.

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Notice lubricant which is visible, and also mandatory during tightening.

Snug tight starting point.

Match marking of socket used to tighten the nut to 1/6th turn past snug tight.

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Baseplate match mark

Visible match marks from turn-of-nut tightening.

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ADDITIONAL RESOURCES & CONTACTS

NDOR Website--Materials & Research Division:

<http://www.nebraskatransportation.org/mat-n-tests/>

(Found at the above M&R link, the following Information is available for download)

- **Nebraska: Inspection Guide for the Installation of High Mast Lighting and Sign Structures, (pdf format).**
- **Instructional Video 1.mpg (2001)**
- **Instructional Video 2.mpg (2008)**
- **Turn of Nut Bolt Rotation Requirements, (pocket reference guides), (pdf format).**
- **FHWA: Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaries, and Traffic Signals, (pdf format).**

NDOR Website--2007 Standard Specifications for Highway Construction:

<http://www.nebraskatransportation.org/ref-man/specbook-2007.pdf>

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